gallon of water, and sprinkled the plant with it. Four hours afterward the lice were all dead, and so was the plant, the leaves being withered as if blighted by heat.

Accepting Prof. Saulsbury's statements concerning the cause of intermittent fever, we might expect from the use of the acid a potent remedy. I have not, however, had the opportunity to test it.

The above is simply a statement of my experience with the remedy. I believe it to be potent for good; but, like other remedies, on being generally introduced, it will meet with condemnation, because it does not fulfil every indication which enthusiasts have claimed for it. It will, however, gradually win by its good effects a prominent position among the list of valuables which enrich our materia medica.

STATE LUNATIC ASYLUM, UTICA, N. Y., March 4, 1868.

NOTE.—A rat killed by inhaling the vapour of the acid, February 21, is at this time, April 20, 1868, as free from the odour of putrefaction as it was the day it died. It has been kept in a warm room during the time. No indication of decomposition is apparent.

ART. III.—*Clinical Observations on the Morbid Effects of Cold.*

By W. E. WATERS, M. D., Assistant Surgeon U. S. Army.

WE have had frequent opportunities of observing the morbid effects occasioned by exposure to severe cold during a residence of two winters at Fort Bridger, Utah Territory. The post is located in an elevated and cold country on the overland stage route, and through it there is more or less travel during the most severe weather of winter. Heavy snow-storms, accompanied by high winds, are of frequent occurrence, and while they prevail it is common for men, perfectly familiar with the country, to get lost and be compelled to remain out until the storms have ceased. Most of the accidents that will be reported in this paper occurred under such circumstances. During the past winter the weather has been unusually cold. In the month of January the thermometer stood below zero continuously at all hours of the day and night for seven consecutive days. The mean temperature, from three registers every twenty-four hours, for that month was $8\frac{79}{100}$° above zero. The latitude of the post is 41° 18′; the longitude, 110° 32′; and it has an elevation of 7010 feet above the sea.

We propose to report in this article typical cases of the various pathological conditions referred to by surgical writers, as resulting from frostbite and freezing. There is one condition, however, which authors describe, viz., the complete and immediate death of a part from the effects of cold before any reaction or inflammation whatever has taken place, which, in our opinion, cannot result from exposure to the atmosphere at the lowest temperature ever experienced. The powers of man to resist the evil effects of low temperature is very great. However languid the circulation may be in a part, and however intense the cold (even when the part be but slightly protected by clothing), if the exposure be not sufficient to destroy the individual, reaction will take place.

The application of intense cold in a solid form, as, for instance, by frozen mercury, may cause the immediate death of the surface with which it is brought in contact, and form an eschar in the same manner as would the contact of a solid body of a very high temperature. But if any considerable portion of a limb should become so congealed by a cold atmosphere as to result in immediate sphacelus, the low temperature necessary to such a result would at the same time destroy life, either by excessive congestion of some of the vital organs, or by a reduction of the temperature of the blood below the standard necessary to secure its continued circulation through the heart.

That a portion of the body will completely and speedily react when apparently lifeless from exposure to cold is easily demonstrated. Dr. Hayes mentions the case of an Esquimaux who had his foot and leg frozen as high as the knee, and "to such an extent that it was stiff, colourless, and apparently lifeless;" but the part reacted, and he recovered so completely that in three days he was walking about with only a slight frost-bite on one of his toes. As will presently appear in the report of a case that came under observation at Fort Bridger, a man had both his feet frozen to such an extent that the parts higher up than the ankles became as stiff as if made of plaster; reaction came on and a high grade of inflammation supervened, but not to terminate so happily as in the case of the Esquimaux. It will also be noticed in this case that while the remainder of the body was so warmly clad as to retain much of its heat, the constitutional effects of the exposure so nearly destroyed life as to require vigorous and prolonged efforts to keep up the vital functions.

A portion of the body may have its heat so rapidly abstracted by the evaporation of a spray of ether or chloride of methylene as to freeze it and render it insensible to pain under the surgeon's knife, but in a few minutes reaction takes place and the part resumes its healthy condition and functions. Some of the lower animals may have their entire bodies frozen stiff and recover; and cocks may have their combs congealed so as to be brittle, and vitality will be restored. It is, therefore, reasonable to suppose that the death of a portion of the body, even to a very superficial extent, cannot follow as the *immediate* effect of abstraction of heat through the atmosphere; but is the result of an inflammatory process which itself is the consequence of the freezing.

CASE I.—Private T. E. G——, Company H, 36th U. S. Infantry, aged about 24; feeble constitution; a prisoner in the guard-house at Fort

Bridger, escaped, with several others, by digging under the walls, at about 8 o'clock on the evening of March 30th. He travelled on foot several miles through the snow, when he was arrested and brought back to the post. Soon after leaving the fort his feet became wet in wading a stream. He was gone about six hours. Was examined at sick call, 8 o'clock the next morning, when both feet were found to be more or less congested, swollen, and painful. Both great toes, with some of the other toes, and the outer edge of the feet were of a different appearance from other parts, being pale and somewhat mottled. He complained of a smart burning and pricking sensation, as if the parts had been exposed to hot fire, and was unable to bear them on the ground in walking. Painted the entire inflamed surface with compound tincture of iodine, and ordered a quarter of a grain of morphia to be taken then and repeated at night, and that he should be kept in his bunk.

April 1. Inflammation rapidly disappearing from the feet, but appearance of toes same as yesterday.

4*th*. Inflammation entirely subsided from both feet, except one great toe, which remains somewhat swollen and tender, though there is no vesication or tendency to ulceration, and the patient is about as usual.

The above case exhibits the most simple of the effects of exposure to cold which require surgical treatment, and if it had not been for one circumstance mentioned, the wetting of the feet, no unpleasant consequences would have resulted. On the evening the prisoners escaped the register of the thermometer, at 9 o'clock, was 30° above zero, and at 7 o'clock the next morning only two degrees lower. During the night it was probably a little colder; but it was not cold enough, nor was the exposure long enough, under ordinary circumstances, to have injured the man's feet had they not been wet at the time. He had frequently, during the winter, worked out of doors in the snow for a longer time than he was absent that night, and when the temperature was much lower, without experiencing any unpleasant results. Five or six other prisoners escaped with G—— and were captured at the same time; and, except one man, whose feet had also been wet, none of them suffered the slightest inconvenience.

The first impressions produced by exposure to cold are the same as those produced by heat. Capillary congestion of the surface takes place, accompanied by the usual symptoms of heat, redness, pain, and swelling, and when the congestion is slight, as in the case reported, no other pathological condition manifests itself. The swelling is attributed only to the distension of the walls of the vessels, which soon resume their natural calibre, and the circulation goes on unobstructed. If the exposure be continued for some time after the parts become congested, a secondary effect takes place, viz., the blood retreats from the surface, the capillaries contract, and some of the blood may coagulate in the subcutaneous veins, leaving the surface pale and of a whitish mottled appearance, as was presented in the toes in the case reported. After a still longer exposure, or when the temperature is lower, an effusion of the watery parts of the blood sooner or later follows, and extensive vesicles form. An example of this kind will be presented in the case to be reported next.

No treatment could be more satisfactory in its results than that of the application to the parts of compound tincture of iodine in such cases as the one reported. It has been my invariable practice, and has never disappointed me. In some cases where the congestion has run into inflammation, which has existed for several days, and the parts are swollen, painful, and presenting the fiery appearance of erysipelas, a few applications have caused the swelling to subside, the pain to cease, and a healthy surface to present itself under the desquamating cuticle.

CASE II.—William Johnson; citizen, aged about 30, healthy, temperate habits, on the morning of December 28th, 1867, started from Muddy Fork, fifteen miles from Fort Bridger, to drive cattle to the post. He was on foot, and there were six inches of snow on the ground. Losing his way, he wandered about all day, and as night came on and it grew colder, he commenced experiencing in his feet, which had been cold for some time, a very painful burning and numb sensation. Fearing that his feet were freezing, he took off his boots and socks. His feet were swollen, red, and painful, with his heels and toes assuming the appearance described in Case I. He then rubbed them persistently with snow for several minutes, and putting on his boots and socks walked all night, reaching the point whence he started early the following morning. His feet were then very painful and congested over most of the surface, but pale and shrunken where the circulation was most languid. He immersed them in cold water for two or three hours, which afforded relief. The following morning vesication commenced about the toes, heels, and ankle-joints. The vesicles were at first filled with a colourless liquid; but after a few hours it began to turn red, and finally assumed a dark-purple colour. On the third day after the exposure (January 1st) he was brought to the post for professional treatment. The toes, heels, outer edge of the feet, and about the ankle-joints were covered with vesicles, as above described, and the whole feet were red, swollen, and painful. Some of the vesicles had been ruptured, but most of them were distended with the dark effusion. The inflamed surface was painted with the compound tincture of iodine, and the vesicles most distended were evacuated by small punctures. The whole was then enveloped with lint spread with a mixture of lime-water and cod-liver oil.

Jan. 3. Inflammation rapidly subsiding; under the vesicles of one of the heels there is some ulceration, and one of the great toes is becoming gangrenous; no line of demarcation forming. Continued treatment.

8th. Line of demarcation formed about the metatarso-phalangeal joint of the mortified toe; patient objects to the removal of the dead part with the knife. Applied poultice of linseed meal to the gangrenous toe, and continued lime-water and cod-liver oil to vesicated and ulcerated surfaces, which are rapidly healing.

23d. Parts nearly healed, except the gangrenous toe, which was removed at the point of separation between the living and dead tissues.

This case is cited as an example of the more serious consequences of exposure for a longer time, and to more intense cold. At nine o'clock on the night the man was out, and at seven o'clock on the morning he got back, the thermometer indicated, respectively, 7° and 12° *below* zero. The atmosphere was dry and clear, and the feet were kept dry, otherwise a more serious condition than that described must have resulted. Other cases have come under my observation of comparative immunity after exposure to a very low temperature in a dry atmosphere, and when the body is kept dry. A remarkable contrast must be observed between the two cases here reported. One of a man exposed for a few hours with his feet wet, when the temperature was only a few degrees below the freezing point; and the other exposed for twenty-four hours, with his feet dry, when the thermometer registered below zero, probably, all the time. It is true, there was a difference in the effects, but not at all in comparison with the difference in the extent of the exposure.

This second case is presented to illustrate the secondary condition that follows exposure. In the first we had an active congestion of the surface, but nothing more; in the second, the same primary effect took place, and was soon followed by an effusion under the cuticle. This effusion never occurs immediately. It usually takes place in from twelve to twenty-four hours after the patient has been removed to a milder temperature. The vesicles that follow a mild form of inflammation are filled with a colourless serum, but more or less of the hæmatin of the blood becomes mixed with it as the grade of inflammatory action rises—as when the exposure is for a long time, or to an intense cold. If the parts have become so disorganized as to result in their destruction by moist gangrene, the contents of the vesicles become very dark-coloured. The other condition that existed in this case will be referred to hereafter in reporting a more extensive mortification.

The severe exposure to which Johnson was subjected would, doubtless, have resulted in much more serious injury had it not been for the very rational treatment he adopted in his own case. Those judicious measures prevented general sloughing, if not gangrene, of the whole feet, and kept the inflammation in bounds. Much of the vesicated surface healed without ulceration of the true skin, and where it occurred healthy granulations soon restored the lost surface.

In the first case attention was directed to the good results that followed painting the congested parts with the compound tincture of iodine. So in this case, the merits of the application of a mixture of lime-water and cod-liver oil to the vesicated and ulcerated surfaces is worthy of special notice. The first application was followed by a very marked relief of the burning and smarting sensation, which the patient represented to be very annoying. Its effect in this way was more mechanical than otherwise, by protecting the sensitive parts from the action of the atmosphere; but its virtues as a mild stimulant and emollient are certainly worthy of consideration. The application of the mixture to frozen feet is attended by similar results as the anointing of burns with the celebrated carron ointment. The parts in the two conditions being so similar, it was decided to apply the carron ointment to the blistered feet in this case; but as no linseed oil could be obtained, and having an abundance of cod-liver oil on hand, the latter was substituted. The effect of the treatment was so highly satisfactory, that I now prefer the improvised ointment to the more popular preparation it was made to imitate. Since adopting this mode of treatment, I learn that it is practised by other surgeons at frontier posts, but have not seen it referred to in any writings on the subject. Their knowledge of its virtues may have been discovered in the same accidental way as by the writer.

CASE III.—Dr. Dunleavy, citizen, *en route* for the Sweet Water Gold Mines near South Pass, passed Fort Bridger in the latter part of December, and, when about fifty miles from the post, lost his way, and remained out for two or three days and nights. The weather was very cold, and the mercury doubtless stood below zero most of the time. The Doctor was warmly clad, and, when not riding about, had the advantage of a fire, and at night slept by one. Knowing the danger to be feared, having spent several years in the Rocky Mountains further north, he was particularly careful to keep his toes in motion as much as possible while riding, though he had on a pair of stout overshoes at the time. Notwithstanding all his precautions the cold was so intense that both feet were, to some extent, frozen when he reached a settlement. The usual phenomena of congestion and vesication presented themselves. As soon as he could communicate with the post, about thirty miles distant, he obtained some tincture of iodine, and painted the feet freely, which afforded speedy relief to the inflammation, except that on the outer edge of one foot. But there, over a space extending from the little toe as far back as the os calcis, and more than an inch in width, was manifested a disposition to slough, notwithstanding the free use of iodine. At first the slough appeared to be very superficial, but as the edges became detached it was discovered to extend deeper in the centre, and separated very slowly notwithstanding constant poulticing. Several weeks elapsed before the whole was removed, and the surface was filled with flabby granulations; healing was accomplished very slowly. The indolent part was dressed with ointment of the oxide of zinc, and the edges touched with a strong solution of nitrate of silver.

Congestion and effusion have already been referred to as consequences of exposure; but in this case the inflammatory action advanced a step further, and extended deeply into the tissues of a part where the circulation was languid, and where there was an abundance of cellular tissue to yield readily to the destructive process. The death of the parts was the result, not of moist gangrene, as sometimes occurs, but of sloughing, wherein the mortification is of a different nature, and a circumscribed eschar results, to be separated by ulceration from the living tissues which surround it. After the exposure had ceased, the part that afterwards sloughed presented no peculiarities as regards appearance or sensation, over other inflamed parts of the same foot; and, under ordinary circumstances, the more remote parts, as the toes, would be expected to yield first to the morbid process; but in this case the capability of resisting inflammatory action was doubtless attributable to the fact that the circulation had been kept more active in them by the motion of the parts, and the abstraction of heat correspondingly less, so that the toes successfully resisted the morbid process, while the edge of the foot could not. Superficial sloughs are thrown off by a process of ulceration extending under and around the dead part, of the same nature as when it separates a mortified limb, which may be destroyed by complete death. In the cases that have come under my observation, where a superficial part has sloughed from being frozen, the reparative process has not been as active as in healing of an ulcerated surface on the same individual; and such is likewise the case where the continuity of the part has been destroyed by ulceration from the surface downwards, without an eschar. It appears, also, different from the ulcerated surface, separating a part attacked with moist gangrene. The granulations, under such circumstances, as will appear in a case to be reported, are very exuberant, and cover the surface of bones left entirely exposed. In the few cases that have come under my observation the difference may have been accidental, or attributable to some collateral cause, and not the result of any fixed laws in process of reparation.

CASE IV.—John Miller, German, aged years, weighing about 140 pounds; health good; habits temperate; a stage-driver, and for several years in the employ of the Overland Mail Company, started from Fort Bridger, going west with an empty sleigh and six horses on the morning of February 9. The snow on the table-land between the fort and the first station west, was about three feet deep, and badly drifted in places. Miller was all day going a distance of ten miles, and as night came on, finding it impossible to reach the station, or extricate his sleigh from a snow-drift, he turned loose his horses, and started to walk in, leaving his buffalo overshoes in the sleigh. The wind was then very high, and the snow flying so thickly that it was impossible to distinguish landmarks; nevertheless he left the road for a " near cut" to the station. Soon he was lost and bewildered, and it was impossible for him to distinguish the direction to the station, or find the road again. He wandered about in the snow all night. The sleigh was discovered and the man missed, and the next morning search was instituted for him. It was nearly noon before he was found; he had wandered about continuously since he left the sleigh, and was quite stupefied from the cold, and so fatigued as scarcely to be able to walk. When discovered he was in the act of preparing a place to lie down in the snow, where he would unquestionably have slept a fatal sleep. He was brought to Fort Bridger as speedily as possible. On getting into the sleigh to come in, he took a little whiskey offered him, and immediately fell asleep, notwithstanding the constant efforts of the man with him to keep him awake. When he reached the fort at about two o'clock P. M. his breathing was stertorous, his pulse almost imperceptible at the wrist, his body pale and cold, presenting all the appearances of a fatal collapse. The skin about the ankles had adapted its surface to the irregularities of the creases in his boots, and had frozen so that when they were cut off, it looked like the surface of a wash-board. The feet and legs, for two or three inches above the ankles, were frozen as stiff as boards. He was placed on a bed at the end of the ward, where there was no fire, and his feet immersed in ice-water as he lay there. It was impossible to arouse him; the presence of a liquid in his mouth failed to excite the act of swallowing, so that no stimulant could be administered in that way. Life appeared so nearly extinct that I feared reaction could not be brought about. A sinapism, containing with the mustard some capsicum, was applied to the epigastrium, and the vapour of strong liquor ammoniæ was carefully but freely administered by inhalation. This was continued uninterruptedly for more than two hours, when he was aroused sufficiently to make an effort to swallow. Small doses of whiskey were then administered at short intervals, and his pulse soon beat stronger, and in another hour the stertor ceased, and he breathed naturally, though the sound sleep continued throughout the night, except when he was aroused to take the stimulant and nourishment. His feet were kept in the water until they had become soft, and reaction in them had begun. They were then gently rubbed with oil of turpentine, and enveloped in a woollen cloth, moistened with that liquid. An attendant was kept by him all night, who administered every two hours, alternately, whiskey and beef-tea. In the morning John awoke to consciousness for the first time after going to sleep in the sleigh, and had no knowledge whatever of what had passed for nearly twenty-four hours.

Feb. 11. Feet and ankles red, swollen, and quite sensitive to the touch. Painted them with comp. tinct. of iodine. No vesication yet observed. Ordered nourishing diet and anodynes.

12*th.* Left foot swollen, painful, and considerably vesicated, particularly about the ankles; swelling slight in right foot and but few vesicles, the appearance indicating that the inflammation will soon end in resolution. Applied dressing of cod-liver oil and lime-water.

17*th.* Skin of both feet and the vesicles assuming a dark colour, more particularly the right, which promised favourably at first; parts continue sensitive, and no indication of gangrene by crepitus or smell; but sloughing is about to take place; any motion of the feet, as in dressing, gives rise to intense pain, which the patient locates in the ankle-joint; the feet were enveloped in poultices of flaxseed meal with a little cod-liver oil added; anodynes increased.

22*d.* Slough completely defined above both ankles, and a line of separation formed. Ulceration on the edges shows it to be superficial, extending only through the skin; pain in the ankle-joints continues, and quite intense when the feet are moved to be dressed; appetite poor; losing flesh; ordered two grains citrate of iron and quinia three times a day.

March 1. Slough separating slowly; general health failing. In addition to tonic, ordered beef-tea three times a day between meals.

10*th.* Slough detaching slowly, and as it progresses downwards towards the ankles, the tissues to a deeper extent are involved, the tendons being exposed, and on one foot both malleoli. Doubtful about being able to save the feet. Ordered, in addition to the stimulants and nourishment previously prescribed, egg-nog and milk-punch, to be taken alternately every three hours.

20*th.* Having given the patient every chance that the most conservative surgeon would advise, and even to an extent to hazard life by the constitutional depression that has resulted, and the slough continuing to thicken as it progresses downwards so as to involve nearly all the soft tissues of the foot, all hope of saving the feet was abandoned. There are also indications of gangrene about the toes. Amputation was regarded as imperative to save life, and both feet were taken off an inch above the ankle-joint. The patient stood the operation well under the influence of sulphuric ether.

25*th.* Doing very well; the greater part of both flaps united by first intention; general condition improving; appetite better; has been taking ale for a few days.

April 12. Stump of left foot where the flaps were entirely covered with skin healed; of the right there had been some ulcerations higher up than the division of the skin, and while the flaps united by first intention, the ulcerated surfaces have not entirely healed, but are cicatrizing rapidly, only a very small space remaining to be covered.

This case is of special interest; it furnishes an example of the vigorous and prolonged, though fruitless efforts of nature, in a healthy subject, to overcome the most serious effects of exposure to cold. At 7 o'clock in the morning, when the driver started, the thermometer stood 4° below zero; at 9 o'clock that night at 1° below, and at seven o'clock the next morning at 1° above. The temperature of the atmosphere at the time of this accident was not so low as that referred to in Case III., nor was the exposure any longer, while the consequences were of a much more serious nature. This is attributable to the following circumstances. The locality of the last accident is proverbally bleak and exposed. The westerly wind sweeps over the plain with great force, and on that day was blowing with unusual violence. The man had the charge of six horses, unaccustomed to the snow, and their management gave him much trouble, so that after labouring with them for nearly twelve hours in going a less number of miles, fatigued and dispirited he had to abandon the team. The mental depression and anxiety therefore acted injuriously. This was more particularly manifested in the constitutional condition that followed; and in Case III. the man kept his feet dry, while in this case the snow being over the boot-tops got into them, was melted by the heat of the body; his socks became saturated with water, and as the cold continued became of such a low temperature as to congeal, and acted as the ready medium of abstracting heat from the parts. Another important consideration was the difference in the temperaments of the two individuals. Johnson had the advantages of the activity of the *sanguine*, while Miller's was very distinctly of the *phlegmatic.*

Attention has already been called to the fact that a portion of the body may be frozen stiff, and remain so for several hours, without resulting in immediate mortification.

We have in this case a repetition of all the conditions reported in previous cases, and to an aggravated extent, together with the addition of a deep-seated inflammation involving the structures of the articulation. The earlier stage, viz., of congestion must have existed for a very short time, as the patient has no recollection of experiencing the burning and smarting sensation complained of by those who suffered from the slighter effects of exposure. The exsanguine condition followed very speedily because of the readiness with which the heat yielded to the moist cold, and also because of the sluggish circulation characteristic of the temperament. The first unpleasant feeling he noticed was a painfully numb, pricking sensation, and this did not last long, for soon all sensation had ceased, and he was reminded that all was not well only by the stiffness of the parts while walking. The collapsed and frozen condition of the outer surface was followed by a loss of heat from the deeper structures, which was the exciting cause of the inflammatory action that extended to the articulations. This condition was the cause of the pain about the ankles of which he complained at an early day, but at that time it was not suspected to exist. The morbid condition of the surface presented the usual appearance attending synovitis, and at first the inflammation seemed to be so superficial that no apprehensions of deeper-seated trouble were felt. When amputation was performed, it was then apparent that inflammation of the joints had existed for some time. They were filled with a sero-purulent fluid and found to be completely disorganized. With this condition existing it would have been impossible to have saved the feet, and had it been known, an earlier amputation would have been resorted to, and considerable suffering arrested. But a more favourable result had been looked for. When sloughing commenced, the toes and the lower part of the dorsum of the feet were but slightly involved in the morbid process. From these parts the cuticle soon separated, leaving an inflamed cutis looking very much as if it would recover without the loss of structure, but higher up around the ankle-joints and over the heels, the true skin was destroyed. At first the slough was supposed to be confined to the skin, but as it became detached, it continued to extend deeper and deeper until there were indications of the morbid action reaching the vessels that passed through the eschar and obliterated their calibre; for on the day the amputation was performed, the parts below that had promised so favourably, exhibited signs of moist gangrene, when nothing of the kind existed elsewhere. Obstruction of the circulation and not inflammatory action was the cause, and in another day in all probability the whole feet would have been gangrenous. After the removal of the feet, incision in the slough demonstrated that it extended through the entire soft parts.

No other portion of the body was injured save one of the fingers, which had a slight frost-bite on it.

The man was very warmly clad, having on at the time he was exposed two pairs of heavy cloth pants, and a very stout overcoat, with a shawl wrapped about his neck and face as high up as his eyes. He had taken every precaution, as stage-drivers generally do in this severe climate, to protect himself against cold, and if he had remained in his sleigh, and kept on his buffalo-skin overshoes, with the aid of his robes he would have suffered no inconvenience, as assistance reached his abandoned sleigh only a few hours after he left it.

CASE V.—John Lewis, very stout framed, over six feet, about 30 years of age, sanguineo-bilious temperament; health good. Started, in company with another man, at three o'clock in the afternoon of January 1st, in the midst of a severe snow-storm, from a stage station fifty miles west of Fort Bridger, to walk to the next station, ten miles distant. They were soon lost; but pressed onward until two o'clock the next morning, when they reached Bear River, and finding a place somewhat protected from the storm by the willows growing on the banks of the stream, they remained there until daylight, pacing up and down on the ice, most of the time, to keep warm. Occasionally they suffered from cold feet, but a little exercise soon made them comfortable again. At daylight they undertook to retrace their steps; but made slow progress—wind blowing very hard, and driving the falling and drifting snow directly in their faces. After advancing a short distance they would have to turn their backs to the storm and rest. Early in the day Lewis' companion became exhausted from cold and fatigue, and finally froze to death, as will appear in report of Case VI. During the day Lewis experienced no great inconvenience from cold feet; but as night came on he again sought a sheltered spot, and after halting a few minutes felt a numbness of his feet; soon all sensation left them, and they appeared as dead weights. He spent the night there, sleeping occasionally for a few minutes, but soon to be awakened by the cold, for he had no blankets; he would then walk, and stamp about to warm himself again. He resumed his travels at daylight, it then being the third day. About noon, when crossing a creek, the ice broke, and he went into the water above his knees, which produced a warm and grateful sensation, and he thought he could walk with more ease afterwards. The snow was two feet deep, and as his feet sank through it afforded some support to his legs as he put his weight on them in walking. This he distinctly noticed when he reached a road, for then he had less control over the motions of his lower extremities and staggered from side to side. Before reaching the road he was nearly exhausted from cold, hunger, and fatigue, and felt, for the first time, like giving up in despair. Just then he observed telegraph poles a short distance ahead, which inspired him with new life and energy, and a walk of a few hundred yards brought him to a cabin. He was so completely exhausted when he reached the door, that before it could be opened he fell heavily against it. When taken in he was unable to articulate, and felt very faint; but a cup of some warm aromatic infusion soon revived him. He had eaten nothing whatever for nearly three days. His boots and socks were cut off; his feet were white, shrivelled, and frozen stiff. A tub of cold water was provided into which they were immersed all night, and the next morning were enveloped in a poultice of boiled onions. When the poultice was removed the following day the whole surface of both feet was covered with vesicles. A poultice of cow manure was then applied, and renewed from day to day, for five days.

He was then taken to a station ten miles distant, when the domestic practice was changed, and a dressing of coal oil applied, and on the next day one of crude petroleum. The oil dressing caused intense pain in the feet, though they had already begun to mortify, as he described them as turning a mottled blue colour, and emitting an offensive smell.

Jan. 10. The man was to-day brought to Fort Bridger, when I saw him for the first time. The above account of his case was then obtained from himself. Both feet are gangrenous, but no distinct line of demarcation is yet observed. Applied flaxseed poultices mixed with Labarraque's solution. Administered anodynes, and put him on a nourishing diet.

15*th*. Lines of demarcation distinctly formed on both feet, and the living and dead parts begin to separate. On one foot this occurs about the tarso-metatarsal articulation, and on the other nearly as high up as the ankle. Amputation was performed directly at the line of demarcation in both feet, separating the metatarsal bones at their articulation in one, and in the other disarticulating as in Chopart's operation. No covering for the bones was obtained in either foot. In the disarticulation of the cuboid and scaphoid from the astragalus and os calcis a partial covering of the muscles was obtained, but in the other the whole articulating surface of the tarsus was entirely uncovered. The patient was under the influence of sulphuric ether during the operation, and appeared quite comfortable after its completion.

I will take occasion, here, to say that in this, and in all the surgical operations I have performed at Fort Bridger, I have obtained valuable assistance from Dr. J. Van A. Carter, who has always manifested a willingness to aid me which I have appreciated, and think worthy of high commendation.

18*th*. Doing remarkably well. Healthy pus forming on the surface and granulations already appearing. Considerable sloughs around the ankles and heels, exposing the end of one os calcis. Simple dressings to the stumps, and ointment of oxide of zinc to the ulcerated surfaces.

Feb. 1. Ulcerated surfaces nearly healed. Piece of the os calcis necrosed, and came away. Stump granulating rather exuberantly, and is touched occasionally with nitrate of silver. The ends of all the exposed bones being rapidly covered with soft tissues granulating around them. General health very good, and patient growing fat.

April 12. Right foot entirely cicatrized; all the ulcers on the left healed, leaving a surface of less than an inch in diameter of the stump to be covered with skin.

During the three days this man was exposed to the weather the thermometer at Fort Bridger ranged from 18° to 36° above zero. The locality where the accident occurred is always much colder than at the post, and must, necessarily, have been many degrees so, on this occasion, to have produced such results. To ascertain the real temperature is impossible, there being no thermometers in that locality. It cannot be decided what would have been the result in this case had a more judicious treatment been adopted in the first instance. The warm emollient applications would facilitate the unfavourable termination that was experienced; but it must be remembered that the feet were in a frozen condition to a greater or less extent for nearly twenty-four hours, when he reached a place of shelter. However, that mortification did not occur for several days is highly probable, and as the parts evidently were not injured to the same extent as in Case IV., and the man a better subject for resisting such an unfavourable termination, a proper treatment of the inflammation *might* have saved the feet.

The ulcerations about the ankles and heels granulated and cicatrized rapidly. These parts, in some places, were destroyed entirely through the skin and cellular tissue; but the ulceration was from the surface downwards, except in one spot over the back part of the heel, where sphacelus occurred, and a piece of the end of the os calcis necrosed and separated.

A point to which attention is particularly directed is the very rapid and healthy granulation and cicatrization, over a large surface, after the removal of the feet. Considering the great value of the heels, and a portion of one foot, to a poor man, who might not be able to provide the most improved artificial means to aid him in walking, every part that could be left was allowed to remain. After the incisions were made, and the parts removed, I must admit that the great extent of exposed surface, without the possibility of obtaining a skin covering, and with the articulating ends of the bones prominent, tempted me to perform a higher amputation at the time. It was decided, however, to give the patient the benefit of the chance, and let the stumps remain as they were. The result has shown the prudence of the practice, for the entire ends of the bones have been thickly covered with granulations of the surrounding soft parts, and at the date of this writing a space not larger than a twenty-five cent piece remains to cicatrize.

CASE VI.—Van Wood, a citizen formerly employed by the Overland Stage Company, started with Lewis, as reported in Case V., to walk to an adjacent station during the prevalence of a severe snow-storm. Their experience for about eighteen hours has already been related.

Van Wood is described by his companion as a man of rather small stature, weighing about 140 pounds. He was without employment or means, travelling through the country seeking some way of obtaining a livelihood. His clothing was scant for so cold a climate, and his subsistence doubtless had also been limited. During the night the two men were together, Van Wood did not appear to suffer much more than his companion from the cold (and neither of them suffered to a great extent); but before they had advanced far the next day he complained of numbness of his body and extremities, and could walk only a very short distance without being compelled to stop and rest. When he stopped he became very drowsy, and after a short time fell asleep at each halt, and his companion had to awaken him to start again. At first he was aroused without difficulty, but always expressed a desire to stop longer. He early gave way to despair, saying his "time had come," and advised his companion to abandon him to his fate, and save himself. By this time he had to be beaten and jerked about with considerable rudeness to keep him awake, or to arouse him when he fell asleep. Soon he lost the control of his limbs, and was unable to walk, when his companion, a stout man, carried him on his shoulder a distance of three miles. He invariably fell asleep as soon as he was put down, and finally slept soundly as he lay on his companion's shoulder. When awake, he fully realized his desperate situation, and frequently insisted on being abandoned. His appearance had become very cadaverous, and as the day was waning, and the danger of both perishing becoming imminent, his companion, realizing the importance of making every exertion to save himself, left the man in a spot as protected from the storm as he could find, and pressed forward alone, hoping to find assistance and return.

Van Wood, when abandoned, is described by his companion as "looking as white as a sheet, and his eyes turning green"—a deception probably occasioned by a contrast between the colour of his iris and his pale skin, which had not been observed before. Before leaving him, he was aroused by rubbing snow on his face and other rough treatment, but vitality had so far left him that he could speak with difficulty, and only in a low whisper.

This case presents an example of a man perishing from the effects of cold and fatigue combined. The tendency to sleep that existed had not extended to that profound coma which precedes freezing to death, for it appears that he could be aroused, though with considerable difficulty, when vitality had nearly ceased. This is remarkably in contrast with Case IV. Concerning his respiration and the circulation nothing definite could be ascertained. His companion does not remember any marked stertor, though it may have existed to some extent. Congestion of some of the vital organs must have occurred, though probably to a very inconsiderable extent, in the brain. As the surface of the body had been observed to be cold and collapsed for several hours, it is quite possible that for a much longer time the skin had ceased excreting effete matters, that the blood had become overcharged with noxious materials, and, circulating through the brain in that condition, had exerted its narcotic and poisonous influences, tending to coma. There may also have been congestion both in the brain and all the splanchnic cavities, occasioning death by a combination of asthenia with apnœa.

This case is also one of interest as demonstrating the difference, in individuals of different temperaments and constitutions, in resisting morbific influences. Lewis is a man combining the characteristics of the sanguine and bilious temperaments, and of a good constitution, that has not been abused by excesses, although he has been subjected to hardships and privations. Van Wood is described as having the very opposite peculiarities. He was of a distinctly-marked phlegmatic temperament, with a poor constitution, more the result of irregularities of life and exposure than natural weakness. The latter, after an exposure of less than twenty-four hours, sank under the depressing influences he encountered, while the former, exposed to the same, had lost none of his physical vigour, as demonstrated in carrying his companion on his shoulder, in a severe storm and through deep snow, a distance of three miles. After abandoning him, he continued exposed to the same severe weather for more than twenty-four hours longer, without shelter except from an occasional growth of stunted bushes, and without food. There is also to be observed as great a difference in their mental constitutions as in their physical. The one was given to despondency and lack of energy, the other was hopeful and determined. His nervous energy operated in sustaining his physical strength; and when the high degree of tension which had characterized it, without any physical means of aiding it, had relaxed, the physical powers sank rapidly, and as soon as he obtained succor he was unable either to stand or to speak.